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(54) **CIRCULAR ROLLING MILL WITH SHAPING ROLLERS AND METHOD FOR CONTROLLING THE POSITION OF A ROLLER OF SUCH A ROLLING MILL**

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See application file for complete search history.

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(57) **ABSTRACT**

This circular rolling mill has a fixed main frame, a pair of cylindrical rollers, internal and external, to shape internal and external radial faces of an annular part and supported by a first secondary frame mounted on the main frame, as well as a pair of conical rollers, upper and lower, to shape opposite front faces of the part and supported by a second secondary frame mounted on the main frame. At least one rack and pinion assembly moves a roller in translation relative to one of the secondary frames. At least one electric geared motor drives the pinion of the rack and pinion assembly. The electric geared motor is fixedly mounted relative to one of the auxiliary frames. A fluid discharge

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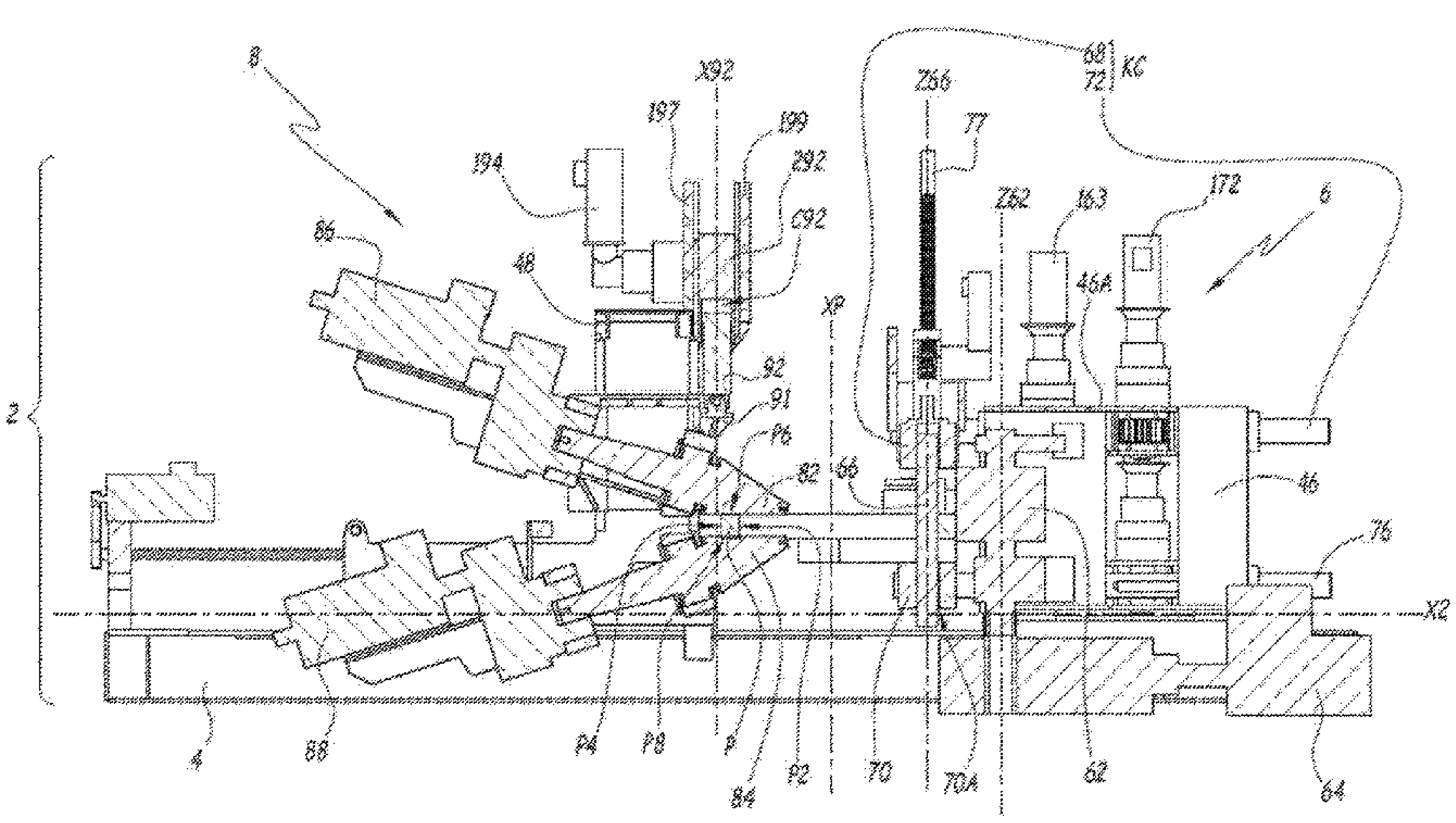

mechanism is interposed in a kinematic chain for transmitting force between the rack and the roller moved by this rack. The fluid discharge mechanism has at least one variable volume chamber supplied with pressurized fluid and the volume of which varies as a function of the relative position of the roller and of the rack.

18 Claims, 10 Drawing Sheets

(51) **Int. Cl.**

B21B 13/10	(2006.01)
B21B 37/52	(2006.01)

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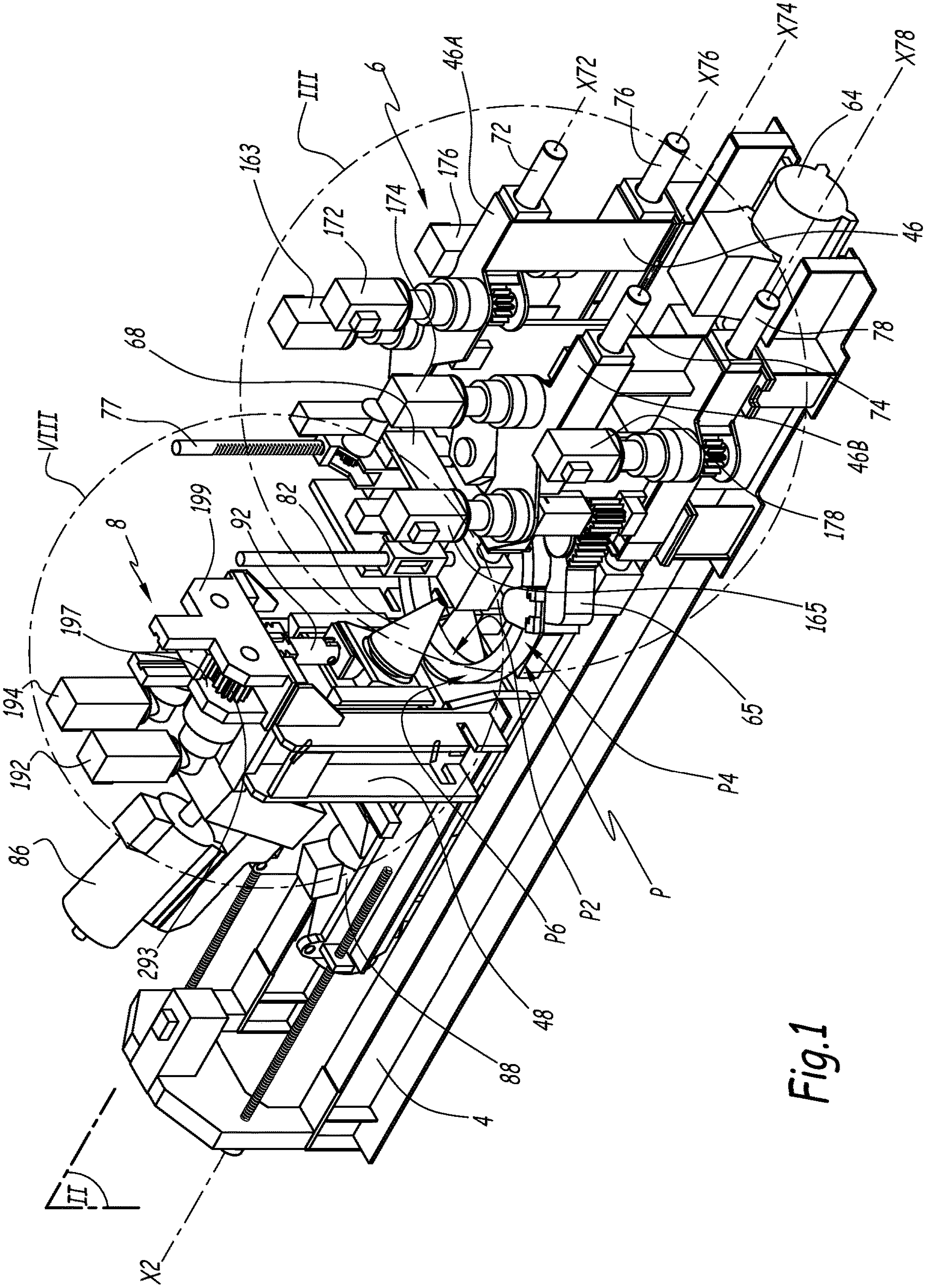
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46A
X72
76
X76
X74
X78
64
163
172
174
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72
46
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VIII
78
74
46B
178
199
92
82
8
197
165
194
192
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P4
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293
P6
P2
48
88
4
II
X2

Fig.1

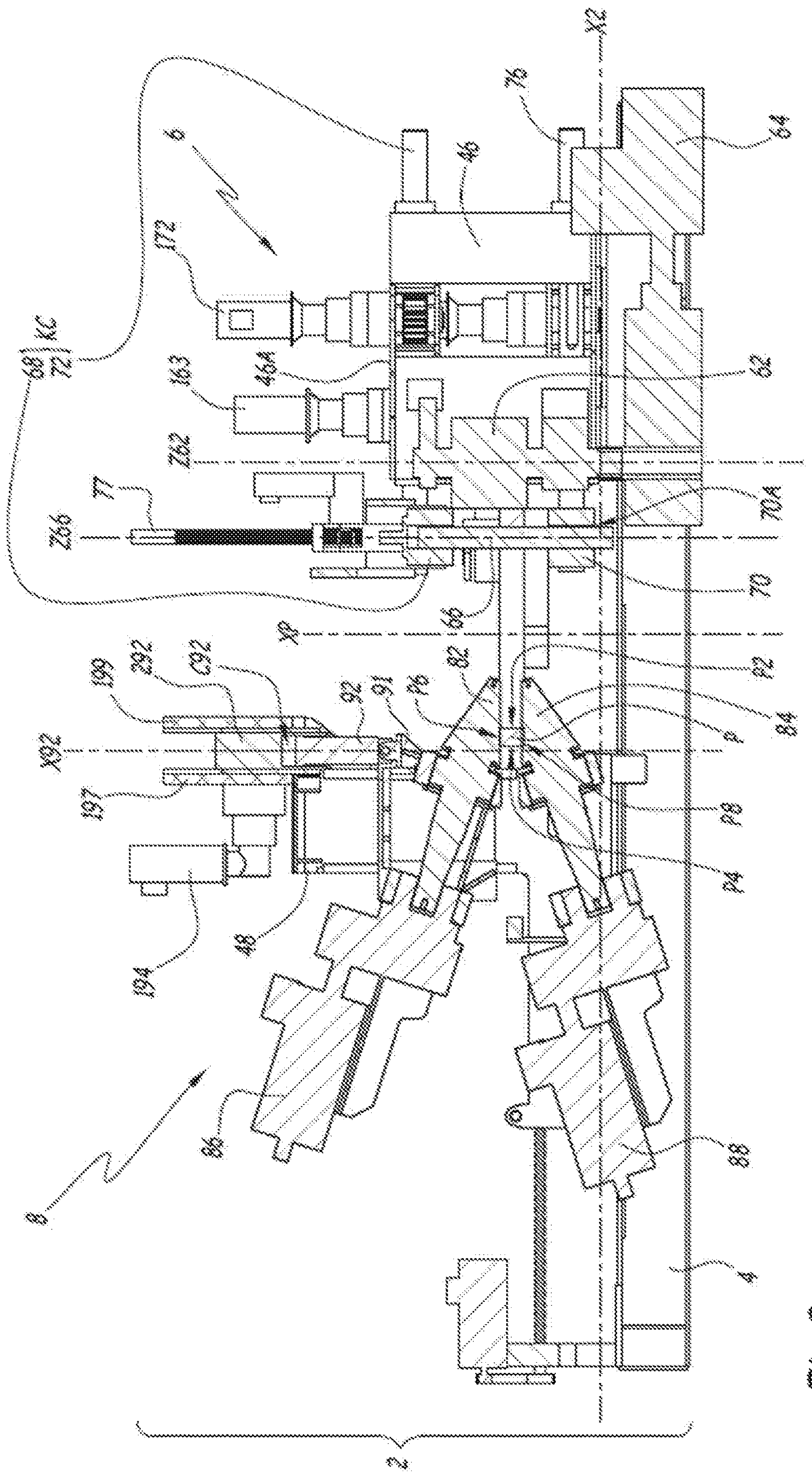
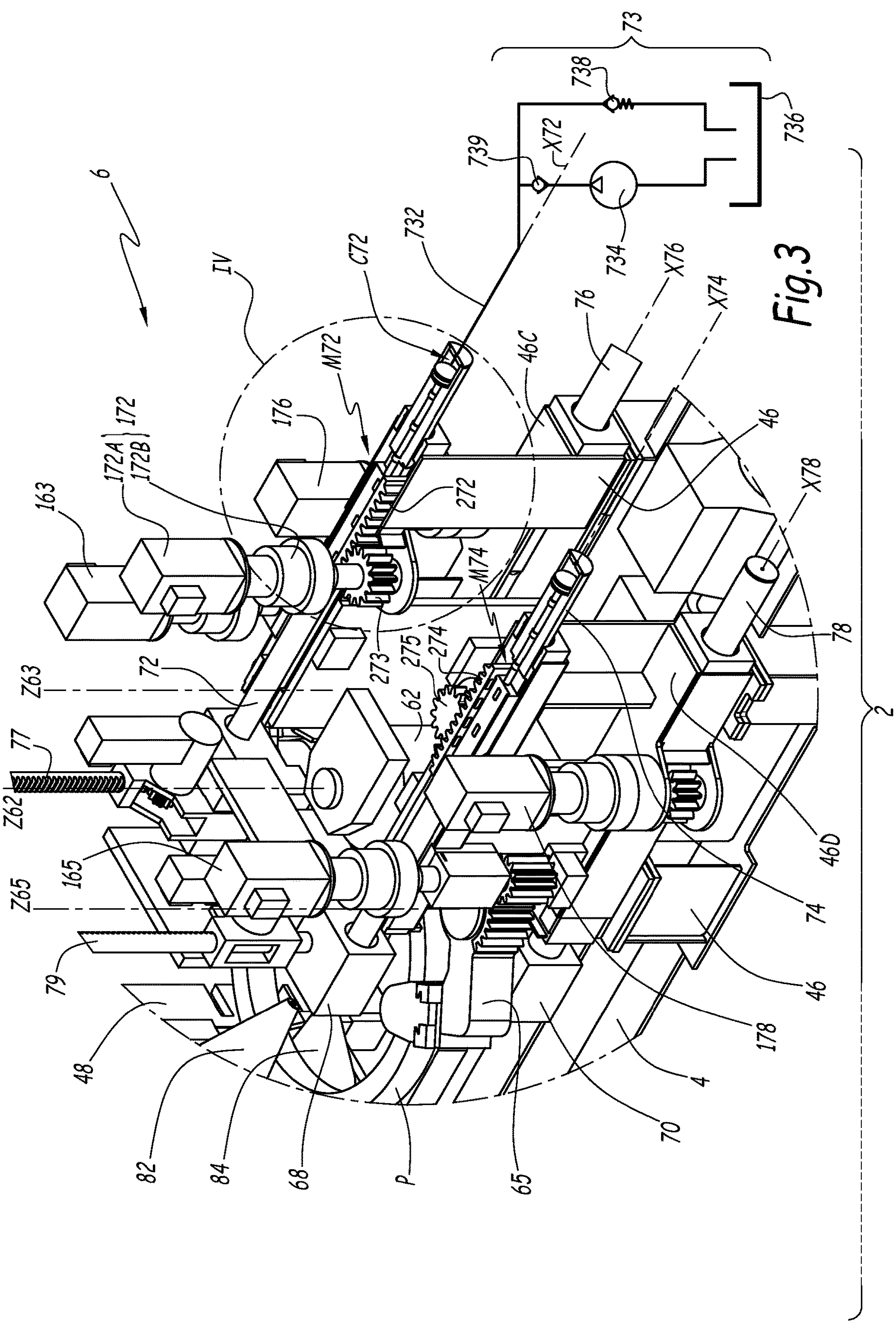


Fig.2


6
IV
C72
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73
738
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X72
734
X76
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76
46C
M72
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172B
172
163
272
273
M74
274
275
72
Z63
62
77
Z62
165
Z65
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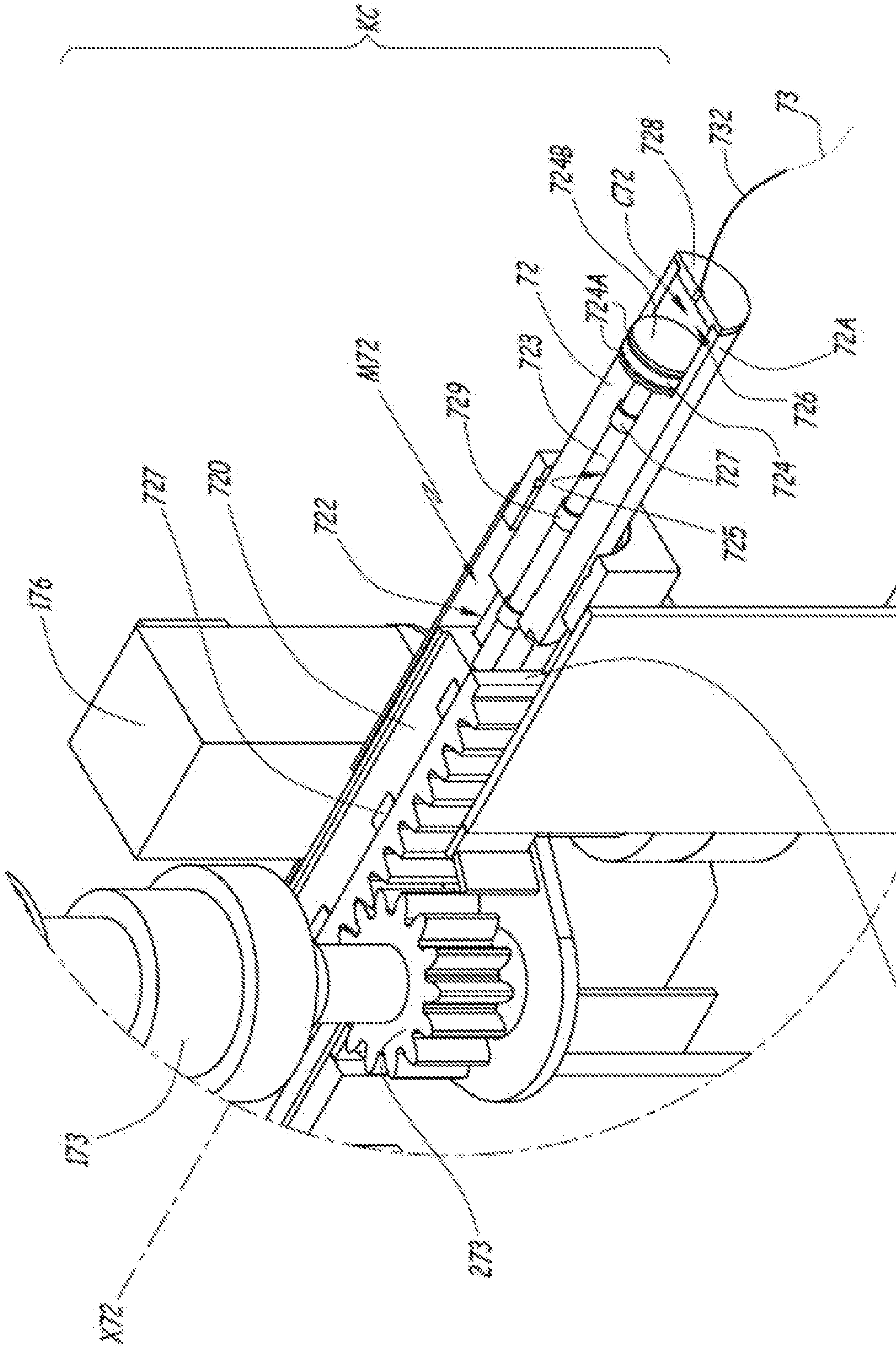
84
68
P
65
70
4
178
46
46D
74
78
X78
2

Fig.3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724A
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72A
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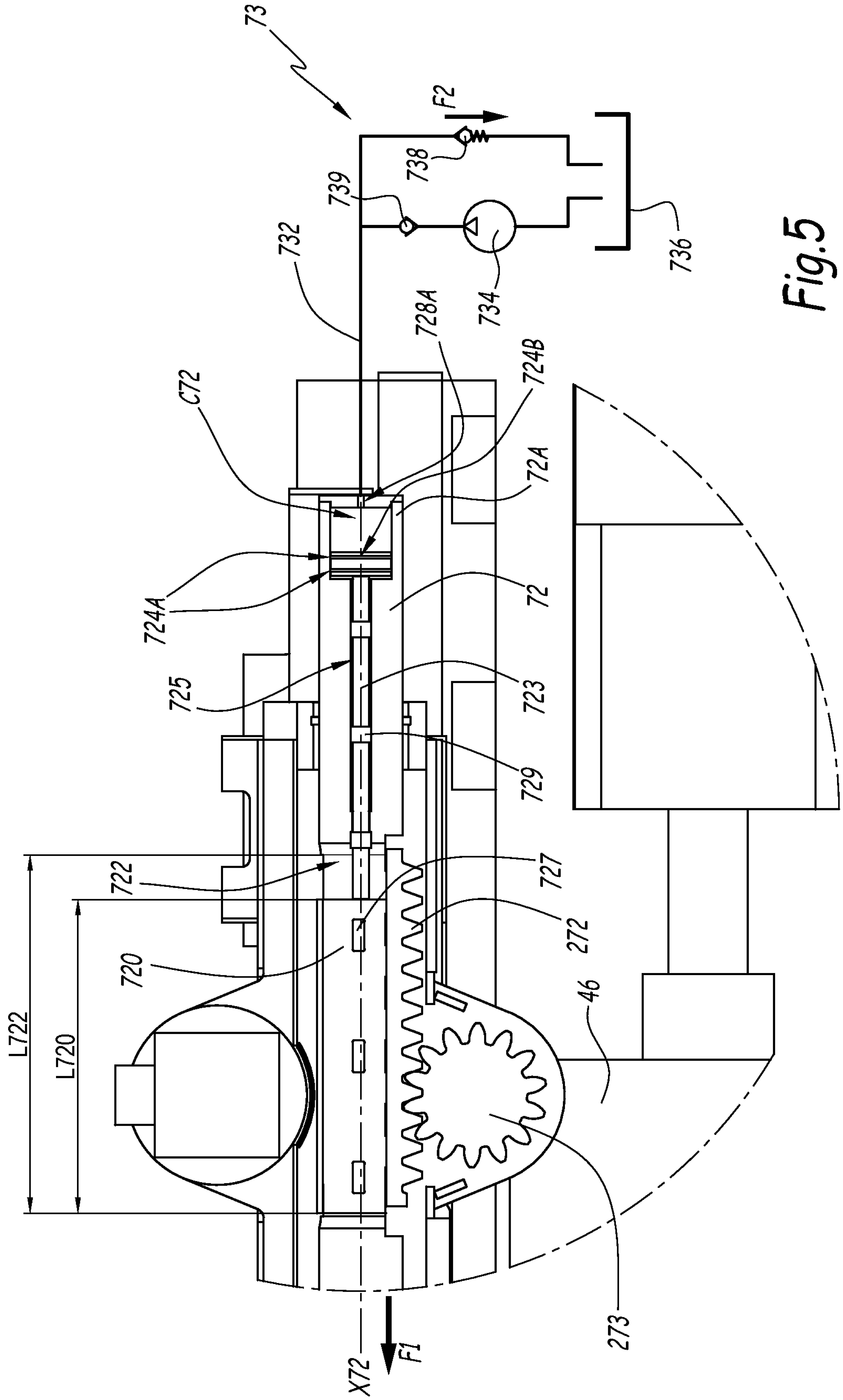
720
722
176
173
X72
273
272

Fig.4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724B
C72
72A
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L722
L720
273
X72
F1

Fig.5

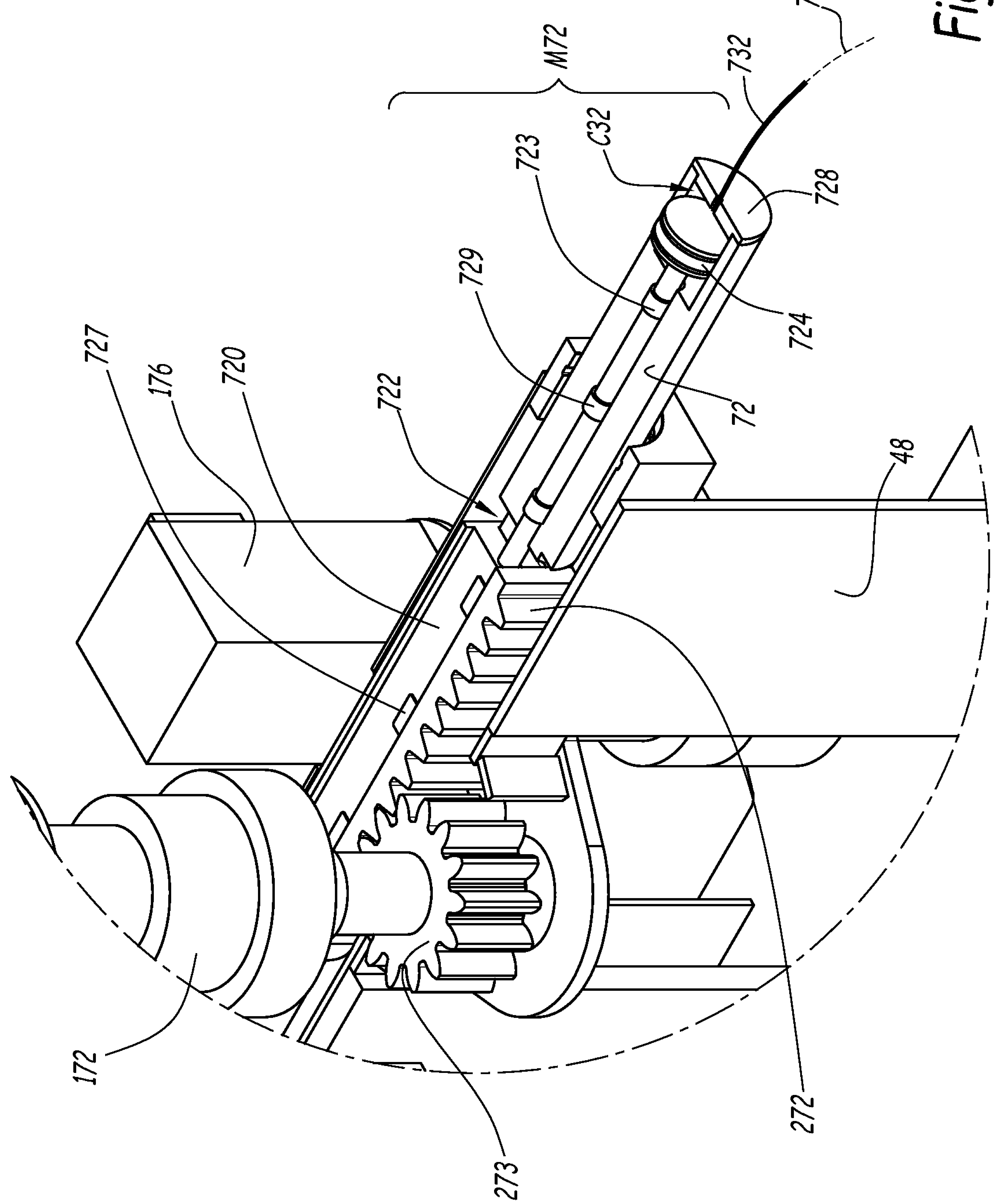
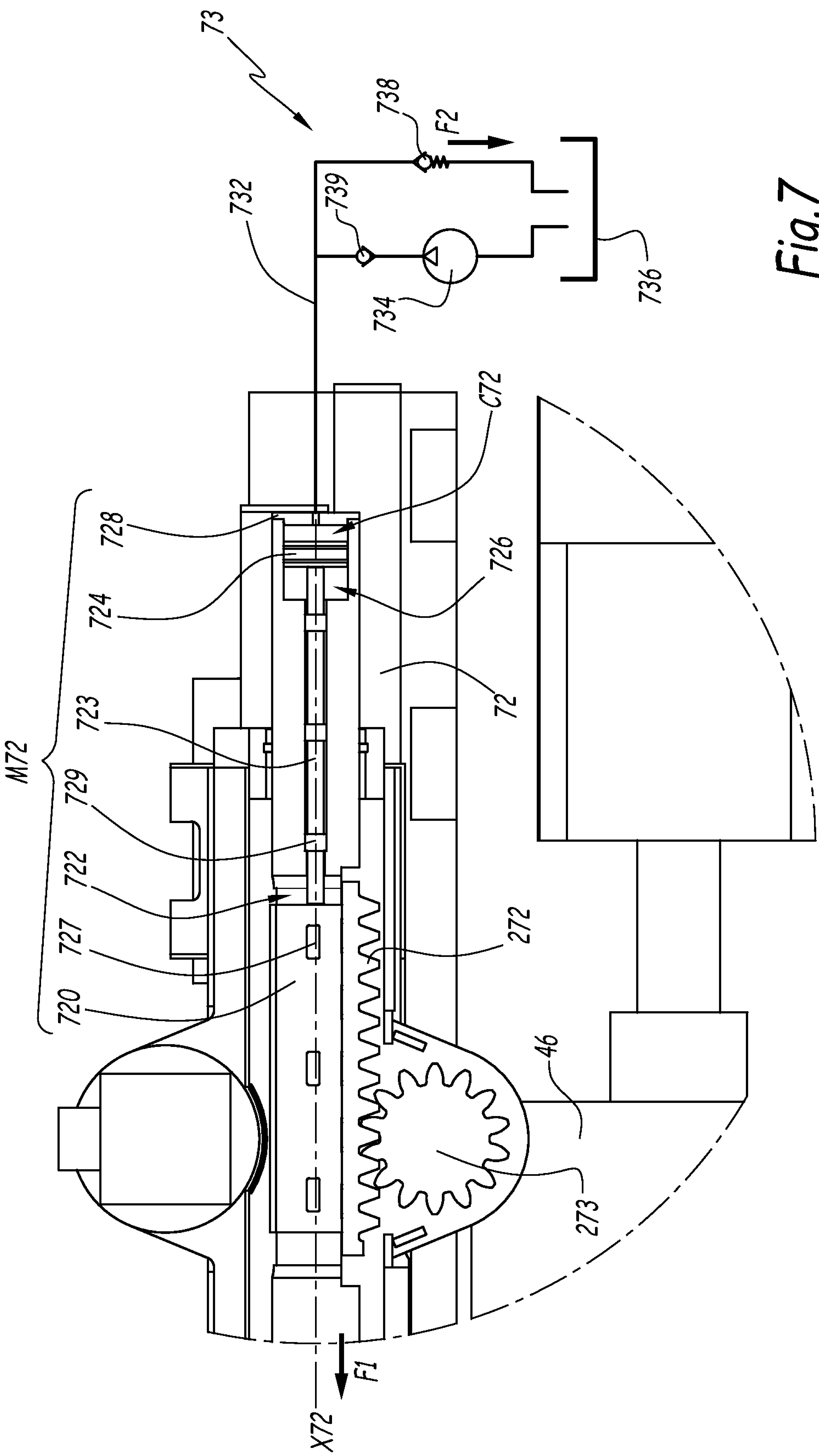


Fig.6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734
C72
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M72
729
722
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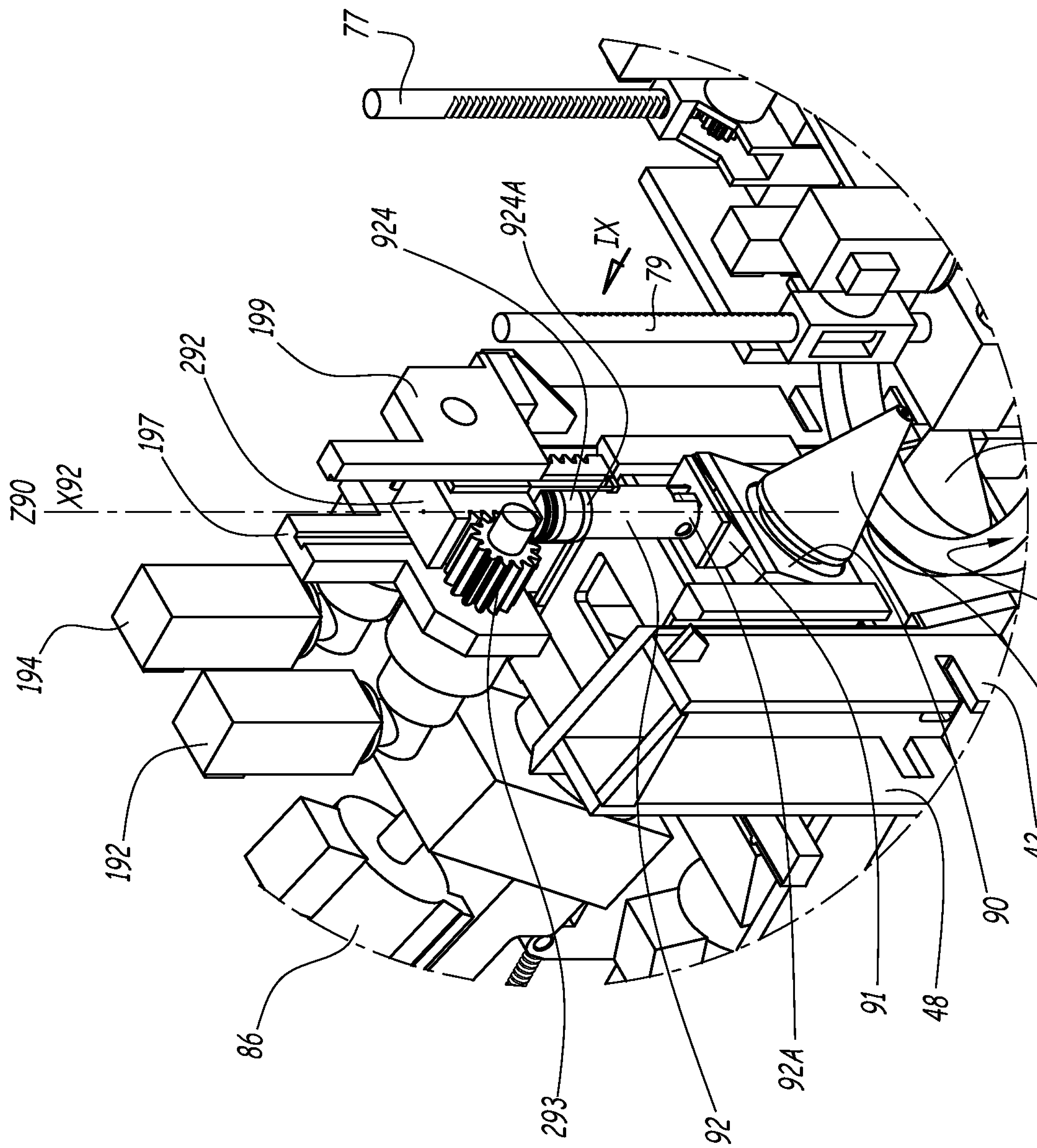
720
46
273
F1
X72

Fig.7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924A
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292
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X92
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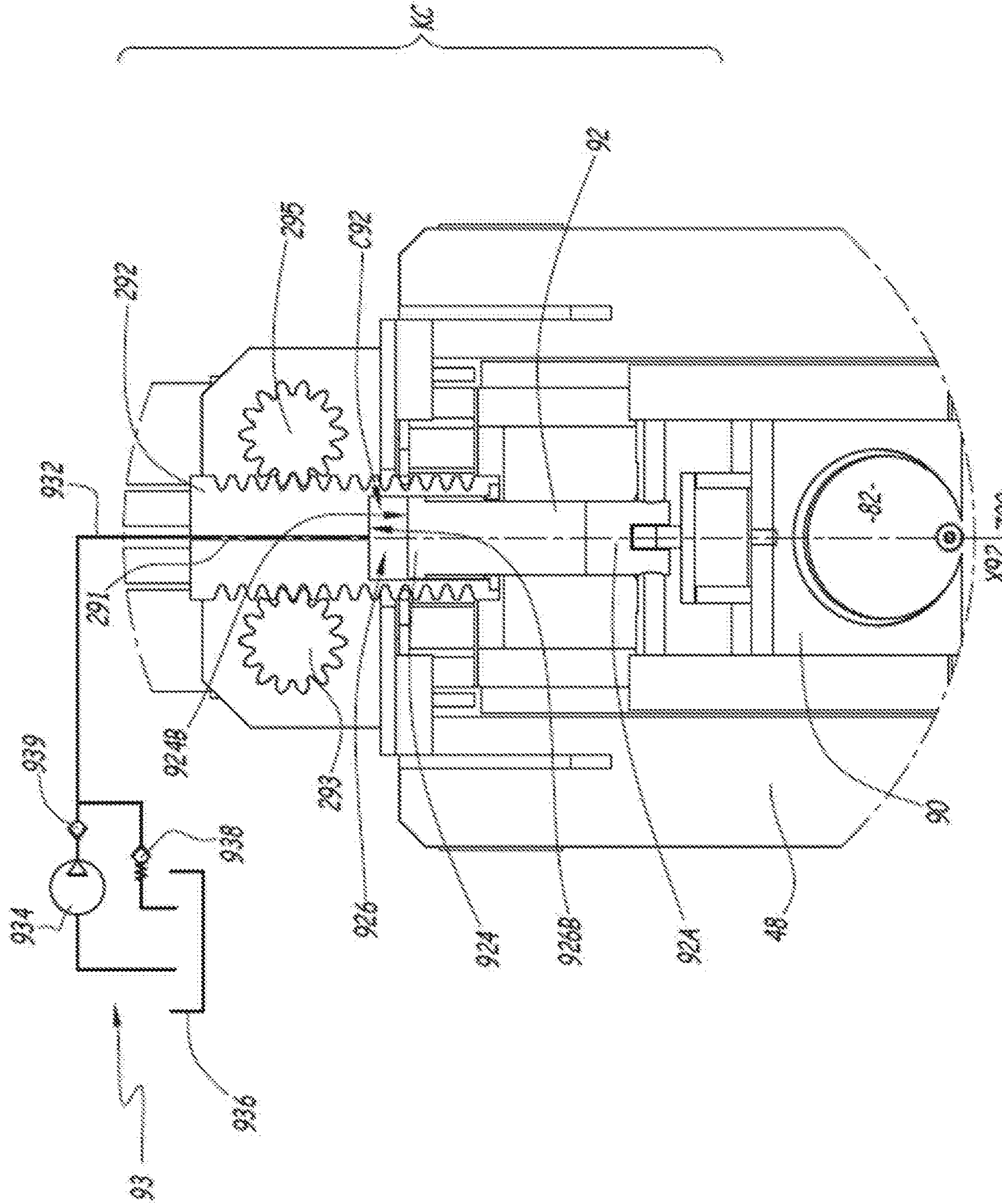
82
P6
84

Fig.8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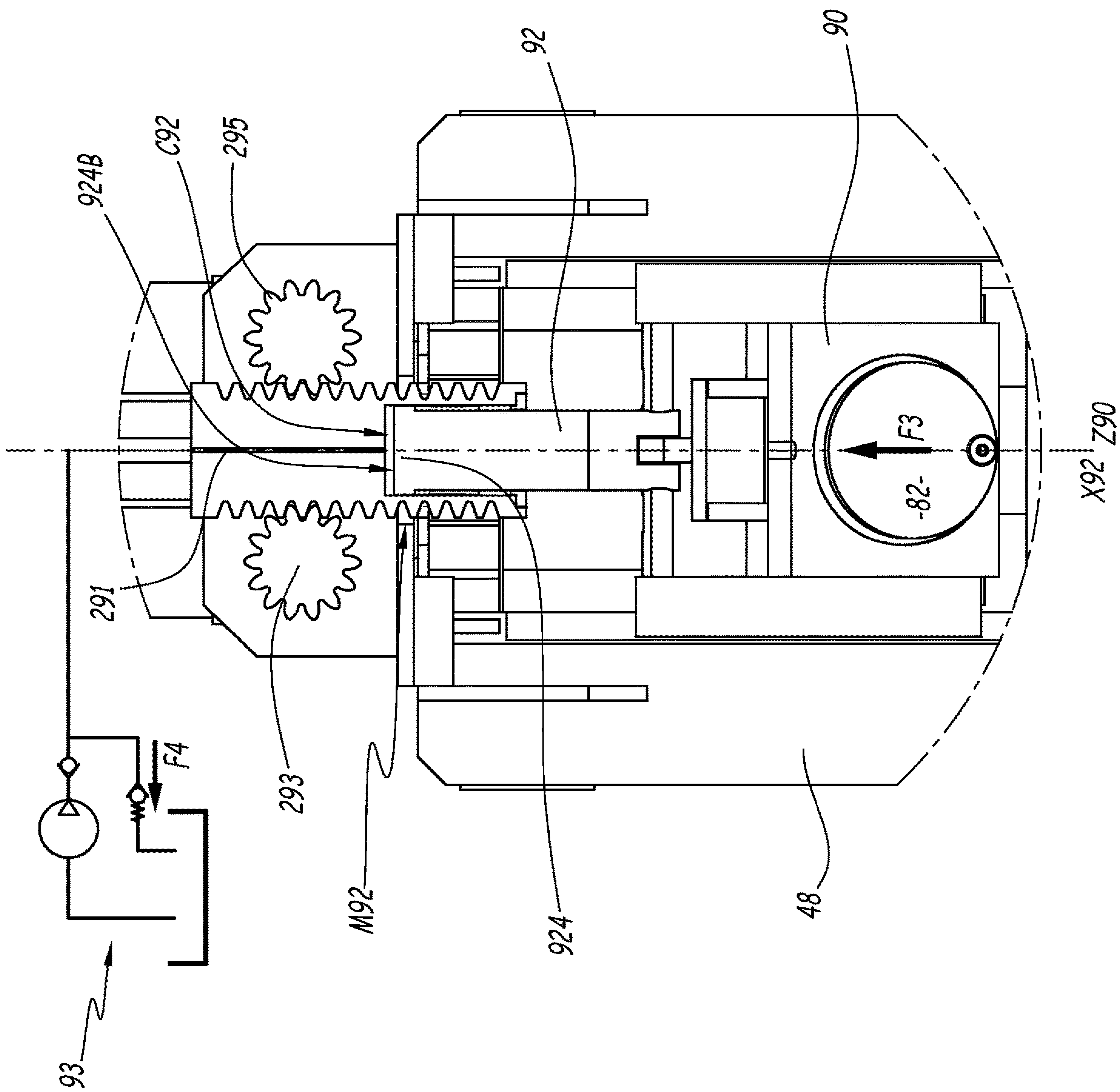
938
934
936
93

Fig.9

Fig.10



CIRCULAR ROLLING MILL WITH SHAPING ROLLERS AND METHOD FOR CONTROLLING THE POSITION OF A ROLLER OF SUCH A ROLLING MILL

CROSS REFERENCE TO RELATED APPLICATIONS

This is a U.S. national phase application under 35 U.S.C. § 371 of International Patent Application No. PCT/EP2017/074736, filed Sep. 29, 2017, and claims benefit of priority to European Patent Application No. 16306289.6, filed Sep. 30, 2016. The entire contents of these applications are hereby incorporated by reference.

FIELD OF THE INVENTION

The invention relates to a circular rolling mill that comprises two pairs of rollers intended to shape radial faces and front faces of an annular part.

BACKGROUND

In this type of rolling mill, it is known that the rollers must be moved, during operation of the rolling mill, to adapt their position to the dimensions of the part being shaped. Traditionally, hydraulic jacks can be used to move the rollers. This requires having a large quantity of pressurized oil, to the point that a relatively bulky hydraulic unit must be provided near the rolling mill.

To offset this problem, it is known from WO-A-2009/125102 to use, in order to move the rollers of a circular rolling mill, pinion-rack assemblies whereof the pinion is rotated by the output shaft of an electric geared motor. To limit the risks of breaking in case of irregularity of the surface with which a roller interacts, it is provided to mount the electric geared motor on a support, which in turn is articulated around the rotation axis of the pinion, relative to a frame of the rolling mill. Furthermore, damping means are provided to damp the pivoting of the support. The mounting of the electric geared motor on an articulated support makes the rolling mill more complex, which increases its cost and causes additional maintenance operations.

The invention more particularly aims to resolve these drawbacks by proposing a circular rolling mill in which the rollers can be moved by an electric geared motor, without it being necessary to install said electric geared motor on a pivoting support.

To that end, the invention relates to a circular rolling mill comprising a fixed main frame, a pair of cylindrical rollers, respectively internal and external, intended to shape internal and external radial faces of an annular part and supported by a first auxiliary frame mounted on the main frame, and a pair of conical rollers, respectively upper and lower, intended to shape opposite front faces of the part and supported by a second auxiliary frame mounted on the main frame. At least one rack and pinion assembly is provided to move a roller in translation relative to the auxiliary frame that supports it and at least one electric geared motor is provided to drive the pinion of this pinion and rack assembly. According to the invention, the electric geared motor is fixedly mounted relative to one of the auxiliary frames, while a fluid discharge mechanism is interposed in a kinematic chain for transmitting force between the rack and the roller moved by this rack. Furthermore, the fluid discharge mechanism comprises at least one variable volume chamber supplied with pressurized fluid and the volume of which varies as a function of the relative position of the roller and of the rack.

Owing to the invention, the fact that the electric geared motor is mounted fixedly relative to the main or secondary frame simplifies the general structure of the rolling mill. During normal operation, the mounting mode of the motor makes it possible to form a fixed point, which allows precise control of the pinion and rack assembly, therefore of the position of the associated roller. In case of irregularity on the surface shaped by the roller, the fluid discharge mechanism makes it possible to absorb the temporary overload transmitted to the kinematic chain, without the rack being moved, therefore without risk of damaging the electric geared motor.

According to advantageous but optional aspects of the invention, such a rolling mill may incorporate one or more of the following features, considered in any technically allowable combination:

- The kinematic chain comprises a transmission bar for transmitting a movement to the roller for moving the rack along a longitudinal axis of the bar and the variable volume chamber is defined between
  - on the one hand, the bar or a part secured to the bar; and
  - on the other hand, the rack or a part rigidly fastened to the rack.
- The variable volume chamber is defined inside the bar.
- Alternatively, the variable volume chamber is defined, along the longitudinal axis of the bar, between the rack and the bar.
- The rolling mill comprises a system for supplying the variable volume chamber with fluid under a pressure greater than or equal to 100 bars, preferably greater than or equal to 200 bars, still more preferably of about 250 bars.
- The kinematic chain is configured so that, in case of irregularity protruding on the surface of an annular part shaped by the roller, the movement caused by this irregularity on the bar tends to drive the pressurized fluid from the variable volume chamber, by reducing its volume.
- The fluid discharge mechanism comprises a piston secured to the rack and one face of which defines the variable volume chamber.
- The piston is mounted sliding inside the bar, along the longitudinal axis of the bar.
- The piston is secured to the rack via a rack support and a connecting rod between the rack support and the piston, the rack support and the connecting rod also being mounted sliding inside the bar, along the longitudinal axis of the bar.
- The rolling mill comprises members for guiding the translation, along the longitudinal axis of the bar, of the rack support and/or the connecting bar, inside the bar, in particular of guiding skids.
- The variable volume chamber is defined between the face of the piston and a cover that closes off an internal volume of the bar, opposite the roller.
- Alternatively, part of the bar is received sealably in an internal cavity defined by the rack and the variable volume chamber is formed by the portion of this cavity not occupied by the bar.
- The variable volume chamber is connected to the pressurized fluid supply system by a pipe that passes through the rack.
- Each roller translatable relative to a secondary frame is moved by a pinion and rack assembly driven by an electric geared motor mounted fixedly relative to said frame, with insertion of a fluid discharge mechanism in

the kinematic force transmission chain between each rack and the roller driven by said rack.

According to another aspect, the invention relates to a method for controlling the position of at least one roller for shaping a face of a part to be shaped within a circular rolling mill that comprises a fixed main frame, a pair of rollers, respectively internal and external, intended to shape internal and external radial faces of this part and supported by a first auxiliary frame mounted on the main frame, as well as a pair of conical rollers, respectively upper and lower, intended to shape opposite front faces of the part and supported by a second auxiliary frame mounted on the main frame, this roller also comprising at least one pinion and rack assembly for moving a roller relative to the auxiliary frame that supports it and at least one electric geared motor to drive the pinion of this pinion and rack assembly. According to the invention, this method comprises the following steps:

a) supplying pressurized fluid to a variable volume chamber integrated into a discharge mechanism interposed in a kinematic force transmission chain between the rack and the roller moved by this rack, to stiffen this kinematic chain during normal operation of the rolling mill, and

b) discharging at least part of the pressurized fluid from the variable volume chamber, owing to a dimensional variation of the kinematic chain, in case of irregularity on the face of the part to be shaped that is shaped by the roller.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood, and other advantages thereof will appear more clearly, in light of the following description of one embodiment of a rolling mill and a control method according to its principle, provided solely as an example and done in reference to the appended drawings, in which:

FIG. **1** is a perspective view of a rolling mill according to the invention;

FIG. **2** is a longitudinal sectional block diagram of the rolling mill, along plane II from FIG. **1**;

FIG. **3** is an enlarged view of detail III in FIG. **1** when the rolling mill is in a first normal operating configuration; for the clarity of the drawing, some support plates and a geared motor have been omitted from this FIG. **3**, and some bars are shown in partial tear-away;

FIG. **4** is an enlarged view of detail IV from FIG. **3**;

FIG. **5** is a top view corresponding to detail IV;

FIG. **6** is a view similar to FIG. **4** when the rolling mill is in a second operating configuration, in case of irregularity on a radial surface of a part during shaping within the rolling mill;

FIG. **7** is a top view corresponding to the detail from FIG. **6**;

FIG. **8** is an enlarged view of detail VIII from FIG. **1** when a guide plate is partially omitted for the clarity of the drawing;

FIG. **9** is an elevation view in the direction of arrow IX from FIG. **8** when the rolling mill is in a first normal operating configuration; for the clarity of the drawing, the guide plate is completely omitted; and

FIG. **10** is a view similar to FIG. **9** when the rolling mill is in a third operating configuration, in case of irregularity on a front surface of a part during shaping within the rolling mill.

DETAILED DESCRIPTION

The rolling mill **2** shown in FIGS. **1** to **10** comprises a fixed main frame **4** that defines a longitudinal axis X**2** of the rolling mill **2**. The frame **2** supports a radial cage **6** that is mounted fixedly on said frame, as well as an axial cage **8** that is movable relative to the frame **4**, along the axis X**2**.

A first auxiliary frame **46** is mounted fixedly on the main frame **4** and constitutes the armature of the radial cage **6**. A second auxiliary frame **48** is mounted on the main frame **4** while being movable along the axis X**2** relative to this main frame. The auxiliary frame **48** constitutes the armature of the axial cage **8**.

Reference P denotes a part in the process of being shaped in the rolling mill **2**. This part is centered on an axis XP that is vertical and perpendicular to the axis X**2**. References P**2** and P**4** respectively denote internal and external radial surfaces of the part. Likewise, references P**6** and P**8** denote upper and lower front surfaces of said part, when it is in place in the rolling mill **2**.

The frame **46** of the radial cage **6** bears a cylindrical main roller **62** mounted rotating around a vertical axis Z**62** and rotated by a main electric motor **64**. The main roller **62** is mounted in the radial cage **6** to bear against the external radial surface P4 of the part P.

The frame **46** of the radial cage **6** also supports a cylindrical secondary roller or mandrel **66** mounted rotating around a vertical axis Z**66** parallel to the axis Z**62**. The secondary roller **66** is supported by a cross-piece **68** that is movable, parallel to the axis X**2**, relative to the secondary frame **46** of the radial cage **6**. To that end, the cross-piece **68** is secured to two bars **72** and **74** that each extend in a direction parallel to the axis X**2**.

The rollers **62** and **66** are solid and have a circular section.

Furthermore, a plate **70** is mounted below the cross-piece **68** and provided with a housing **70**A for receiving the lower part of the secondary roller **66**. This plate **70** is also movable relative to the auxiliary frame **46** while being supported by two bars **76** and **78**.

References X**78**, X**74**, X**76** and X**78** respectively denote the longitudinal axes of the bars **74** to **78** that are parallel to the axis X**2**.

The radial cage **6** also comprises two centering arms of the part P, only one of these centering arms being visible in FIG. **1** with reference **65**.

A lifting system with racks **77** and **79** makes it possible to lift the cross-piece **68** during the placement of the part P in the rolling mill **2**, then to lower it to insert the lower portion of the secondary roller **66** into the housing **70**A of the plate **70**.

Several electric geared motors are provided in the radial cage **6**, namely:

two electric geared motors **172** and **174** for driving the bars **72** and **74**, along their respective longitudinal axes X**72** and X**74**,

two electric geared motors **176** and **178** for driving the bars **76** and **78**, along their respective longitudinal axes X**76** and X**78**,

two electric geared motors **163** and **165** for rotating the centering arms **65** and equivalent means, around vertical axes Z**63** and Z**65**.

The geared motor **172** comprises an electric motor **172**A and a reduction gear **172**B. The other geared motors have the same structure, each with an electric motor associated with a reduction gear.

In FIG. **3**, the geared motor **174** is omitted, to make it possible to view the bar **74** and the associated pinion **273**.

The bars **72** to **78** make it possible to transmit a displacement movement to the roller **66**, parallel to the axis X**2** and each of the axes X**72** to X**78**, generated by the geared motors **172** to **178**.

Each of the geared motors **172** to **178** is mounted fixedly relative to the auxiliary frame **46** of the radial cage **6**. For example, the geared motor **172** is supported rigidly by a plate **46**A belonging to the auxiliary frame **46**. Likewise, the geared motor **174** is supported rigidly by a plate **46**B belonging to the auxiliary frame **46**. The geared motors **176** and **178** are supported by plates **46**C and **46**D of the auxiliary frame **46**. For the clarity of the drawing, the plates **46**A and **46**B are omitted in FIGS. **3** to **7**. One can see in FIG. **1** that they also support the geared motors **163** and **165**. However, this is not mandatory.

During normal operation of the rolling mill **2**, the part P is compressed radially between the rollers **62** and **66**, which are rotated, around axes Z**62** and Z**66**, directly by the motor **64**, for the roller **62**, and indirectly through the part P, for the roller **66**.

A pinion and rack assembly is used to transmit a movement from each geared motor **172** to **178** to the secondary roller or mandrel **66**, in order to control the position of this roller in translation along the axis X**2**.

Thus, a pinion **273** is mounted on the output shaft of the reduction gear **172**B. This pinion **273** cooperates with a rack **272** mounted on the bar **72**.

The mounting of the rack **272** on the bar **72** is rigid in the normal usage configuration of the rolling mill **2**. This mounting, however, comprises a degree of freedom, which can be implemented in case of irregularity on the surface P**2** of the part P, in a direction where a protruding relief present on this surface P**2** tends to move the secondary roller or mandrel **66** toward the axis XP. Likewise, a degree of freedom is implemented in the mounting of the rack **272** on the bar **72** when an irregularity results from a protruding relief on the surface P**4** that tends to push back the part P and the secondary roller **66** toward the axis XP, by reaction against the main roller **62**, the axis Z**62** of which is fixed relative to the auxiliary frame **46**.

To that end, and as visible in FIGS. **3** to **7**, a fluid discharge mechanism M**72** is integrated into kinematic chain KC between the rack **272** and the roller **66**, specifically into the bar **72** and makes it possible to allow a relative movement, along the axis X**72**, between the roller **62** and the rack **272**, more specifically between the rack **272** and the bar **72** that is rigidly fastened to the roller **66**, along the axis X**2**, via the crosspiece **68**.

In FIG. **3**, the lids **46**A and **46**B are omitted and the bars **72** and **74** are shown with half tear-away in a horizontal plane. This makes it possible to view the mechanism M**72** and the equivalent mechanism M**74** associated with the bar **74**.

The mechanism M**72** comprises a rack support **720** rigidly connected to the rack **272**, for example by screws, not shown. This support **720** is received in a housing **722** arranged inside the bar **72**, with an axial length L**722**, measured parallel to the axis X**72**, which is greater than the axial length L**720** of the support **720**, also measured parallel to said axis. Thus, the support **720** can slide inside the housing **722**, parallel to the axis X**72**. The mechanism M**72** also comprises a piston **724** that is positioned in an end housing **726** arranged at the end **72**A of the bar **72** that is opposite the cross-piece **68**, therefore the secondary roller **66**. The end housing **726** is closed off by a cover **728** rigidly fastened to the bar **72**.

The mechanism M**72** also comprises a connecting rod **723** between the support **720** and the piston **724**. The rod **723**, which for example is in simple bearing against the support **720** and the piston **724**, is positioned in a central and longitudinal channel **725** of the rod **72** that connects the housings **722** and **726** to one another. The compression of the rod **723** between the support **720** and the piston **724** makes it possible to create a rigid connection between the parts **720**, **723** and **724** in translation parallel to the axis X**72** when the support moves the piston to the right in FIG. **5** or when the piston moves the support to the left in this figure.

The parts **72**, **272**, **720**, **723** and **724** are made from metal, for example steel. Guide skids **727**, for example made from bronze, are provided on the support **720** to guide it inside the housing **722** and facilitate its sliding. Likewise, guide rings **729**, for example made from copper, are provided around the rod **723**, inside the channel **725**. Alternatively, only the skids **727** or **729** are provided.

The piston **724** is equipped with sealing gaskets **724**A that allow it to isolate part of the end housing **726**, situated between its face **724** turned toward the cover **728** and this cover, of the channel **725**. Thus, a variable volume chamber C**72** is defined in the end housing **726**, between the face **724**B of the piston **724** and the cover **728**.

This variable volume chamber C**72** is supplied with pressurized oil through an orifice **728**A of the cover **728** and a pipe **732** that belongs to a supply system **73** supplying the chamber C**72** with pressurized oil, with a pressure greater than 100 bars. In practice, the pressure delivered by the system **73** is chosen to be greater than 200 bars, preferably around 250 bars. The system **73** may comprise, as shown schematically in FIGS. **3**, **5** and **7**, a pump **734** that delivers oil at the input pressure, by drawing it from a tub **736**, and a tared nonreturn valve **738** connects the pipe **732** to the tub **736**. Another nonreturn valve **739**, mounted in the opposite direction from the nonreturn valve **738**, at the outlet of the pump **732**, prevents the oil from circulating through the pump, in the opposite direction, i.e., from its outlet toward its inlet.

Thus, the system **73** makes it possible to deliver, inside the chamber C**72**, oil at a pressure equal to the output pressure of the pump **734**. The valve **738** is preferably tared such that, if the pressure in the chamber C**72** and in the pipe **732** exceeds the output pressure of the pump **734**, the oil present in the pipe **732** is returned to the tub **736**, through said valve.

The system **73** is a system known in the hydraulic field. In light of the volume of oil that it contains, around one or two liters, it is much easier to implement and much less expensive than the units traditionally used in rolling mills to supply jacks provided to move the shaping rollers.

The discharge mechanism M**72** comprises the bar **72** as well as the parts and volumes **720** to **729**.

By default, the pressure of the oil present in the chamber C**72**, on the order of 250 bars, is sufficient to stiffen the kinematic link between the rack **272** and the bar **72**, therefore between the rack **272** and the secondary roller **66**, during normal operation of the rolling mill **2**.

The bars **74**, **76** and **78** are also connected to the motors **174**, **176** and **178** by kinematic chains KC that each include a fluid discharge mechanism of the type of the mechanism M**72**, the mechanism M**74** used for the bar **74** being visible in FIG. **3**, while the corresponding mechanisms M**76** and M**78** used for the bars **76** and **78** are hidden by the plates **46**C and **46**D. The discharge mechanism M**74** is inserted between, on the one hand, an assembly comprising a pinion **275** and a rack **274**, and, on the other hand, the cross-piece **68**, via the bar **74**. The mechanisms M**76** and M**78** are inserted between, on the one hand, the pinion and rack assemblies mounted at the base of the geared motors **176** and **178** and, on the other hand, the plate **70**.

By default, the rolling mill is in the configuration of FIGS. **3** to **5**.

In FIG. **3**, only one supply system **73** is shown. In practice, it is possible to provide such a system to supply the discharge mechanism M**72**, M**74** or equivalent associated with each bar **74** to **78**, or a system shared by some or all of these mechanisms.

In case of relief protruding on one of the radial surfaces P**2** or P**4** of the part P, the secondary roller **66** is moved temporarily toward the axis XP, which drives the movement of the cross-piece **68** and the plate **70** in the same direction, toward the left in FIG. **2**.

This movement is transmitted to the bars **72** to **78**, which are rigidly connected to the parts **68** and **70**.

Hereinafter, we consider what happens at the bar **72**, with the understanding that the operation is the same at the bars **74** to **78**.

Under the effect of the temporary movement of the cross-piece **68**, the bar **72** is moved abruptly toward the axial cage **8**, in the direction of arrow F**1** in FIG. **7**. This movement should be prevented from being transmitted to the geared motor **172**, to limit the risks of breaking and premature wear of this equipment. This movement of the bar **72** is transmitted to the cover **728**, which results in increasing the oil pressure inside the variable volume chamber C**72**. This pressure increase is reflected by the discharge of the oil from the chamber C**72** toward the supply system **73**, through the orifice **728**A. In this case, the pressure of the oil leaving the chamber C**72** is greater than the output pressure of the pump **734** and the oil, blocked by the nonreturn valve **739**, flows in return toward the tub **736**, through the valve **738**, as shown by arrow F**2** in FIG. **7**.

In other words, due to the movement of the bar **72** in the direction of arrow F**1**, the piston **724**, which is rigidly fixed to the rack **272** through the rod **723** and the support **720**, moves inside the housing **726** in a direction reducing the volume of the chamber C**72**. This makes it possible, in the coordinate system of the secondary frame **46**, for the piston **724**, the rod **723**, the support **720** and the rack **272** to remain fixed, while the bar **72** moves in the direction of arrow F**1**. In other words, the discharge mechanism M**72** allows a relative movement of the rack **272** and the bar **72**, which prevents the transmission to the pinion **273** and, through it, the geared motor **172**, of a violent acceleration that could damage the motor **172**A and/or the reduction gear **172**B. The discharge mechanism M**72** therefore constitutes a mechanism for protecting the electric motor **172**A, the reduction gear **172**B and the pinion and rack assembly **272**-**273** against violent accelerations that could result from surface irregularities of the part during shaping in the rolling mill **2**.

Comparing FIGS. **5** and **7** makes it possible to note that, although the bar **71** has moved to the left, in the direction of arrow F**1**, the rack **272** and the pinion **273** have kept their positions, due to the reduction in the volume of the chamber C**72**.

The axial cage **8** comprises two conical rollers **82** and **84** intended respectively to act on the upper front surface P**6** and the lower front surface P**8** of the part.

The conical rollers **82** and **84** are each rotated by an electric motor **86** or **88** supported by the auxiliary frame **48**.

The roller **82** is supported by a platen **90** that is vertically movable, along an axis Z**90** parallel to the axes Z**62** and Z**66**, relative to the secondary frame **48**.

To that end, the platen **90** is rigidly fastened to a shoe **91**, which in turn is hitched to the lower end **92**A of a bar or column **92**. Like the bars **72** to **78**, the bar **92** makes it possible to transmit, to the roller **82**, a translational movement along its longitudinal axis X**92** combined with the axis Z**90**.

The movement of the bar **92** along the axis Z**90** is controlled by a double-toothed rack **292**, in turn controlled by two geared motors **192** to **194** mounted fixed on the frame **48**. Pinions **293** and **295** are respectively mounted on the output shafts of the geared motors **192** and **194** and simultaneously mesh with the two provided toothings, on either side of the axis Z**90**, on the rack **292**.

The rack is guided in translation along the axis Z**90** by rails formed in guide plates **197** and **199**, the plate **199** being in partial tear-away in FIG. **8** and completely removed in FIGS. **9** and **10**, for clarity of the drawings. The plates **197** and **199** are part of the auxiliary frame **48**. The geared motors **192** and **194** are attached on the frame **48** through the plate **197**.

The upper end of the bar **92** forms a piston **924** that is engaged, sealably owing to a gasket **924**A, in a hollow housing **926** arranged in the lower part of the rack **292**, at the center thereof. This constitutes a variable volume chamber C**92** defined between the upper surface **924**B of the piston **924** and the bottom **926**B of the housing **926**. A pipe **291** passes through the rack **292** over its entire height, from the housing **926**, which makes it possible to connect the chamber C**92** to a system **93** for supplying this chamber with pressurized oil. The system **93** comprises a pipe **932**, a pump **934**, a collection tub **936**, a tared nonreturn valve **938** and a nonreturn valve **739**.

In practice, the supply system **93** may or may not be identical to the supply system **73**. These systems may be combined.

During normal operation of the rolling mill **2** shown in FIGS. **8** and **9**, the pressure in the chamber C**92** is sufficient for the kinematic chain KC between the rack **292** and the upper conical roller **82** to be rigid, which allows precise control of the height of said roller.

In case of irregularity protruding on the upper front surface P**6** or on the lower front surface, the roller **82** is moved upward, in the direction of arrow F**3** in FIG. **10**, which is reflected by a vertical translation toward the top of the platen **90**, the shoe **91** and the bar **92**. This results in driving the oil present in the chamber C**92** toward the system **93**, therefore toward the tub **936** through the valve **938**, as explained above regarding the bar **72** and the supply system **73**, which is shown by arrow F**4**.

The operation here is comparable to that mentioned previously regarding the discharge mechanism M**72**. Therefore, formed in the axial cage **8** is a discharge mechanism M**92** that allows precise control of the height of the conical roller **82** relative to the auxiliary frame **48**, during normal operation of the rolling mill **2**, and accommodation of any surface irregularity on one of the front surfaces P**6** or P**8**, without risking damaging the geared motors **192** and **194**, while the latter are mounted rigidly relative to the secondary frame **48**.

Alternatively, the systems **73** and **93** can be replaced by other systems for supplying the variable volume chambers C**72**, C**74**, C**92**, etc. with pressurized oil at a given pressure. It is in particular possible to use an accumulator reservoir loaded with oil at the desired pressure and associated with a tared discharge valve, or an overloading chamber. In the case of an overloading chamber, the rod **273** is rigidly connected to the support **720** and the piston **724**, which makes it possible to suction oil into the overloading chamber, like a syringe, before placing the variable volume chamber C**72** or equivalent means under a pressure of about 250 bars while pushing back the piston **724**, after having cut the communication between this chamber and the overloading chamber.

In the example described above, the invention is implemented to control the movement, in translation with respect to the frames **46** and **48**, of the rollers **66** and **82**. Alternatively, it can be used for only one of these rollers.

According to a variant of the invention that is not shown, the bars **72** and **74**, on the one hand, and the bars **76** and **78**, on the other hand, can be connected to one another by rear cross-pieces positioned opposite the cross-piece **68** and the plate **70**. In this case, a pinion and rack assembly driven by one or several geared motors can be provided to control the movement of each rear cross-piece along the axis X**2**. The structure of the pinion and rack assembly mounted on the auxiliary frame **46** can be inspired by that shown in the figures for the axial cage **8**, with equivalent of the bar **92** that is positioned horizontally and that attacks each rear cross-piece, in a separation direction relative to the axis Z**62** of the main roller **62**.

According to another variant, a single pinion and rack assembly is used to move both rear cross-pieces, and through them, the four columns. According to still another variant, a single cross-piece connects the four bars **72** to **78**.

The number of traction bars used to control the translation of the roller **66** along the axis X**2** may be different from four.

The embodiment and the variants considered above may be combined to generate new embodiments of the invention.

The invention claimed is:

1. A circular rolling mill comprising:

a fixed main frame;

an internal cylindrical roller intended to shape an internal radial face of an annular part and an external cylindrical roller intended to shape an external radial face of the annular part and rotated by a first driving electric motor, the internal cylindrical roller and the external cylindrical roller being supported by a first auxiliary frame mounted on the fixed main frame;

an upper conical roller intended to shape a front face of the annular part and a lower conical roller intended to shape an opposite front face of the annular part, the upper conical roller and the lower conical roller being each rotated by a second driving electric motor and supported by a second auxiliary frame mounted on, and movable with respect to, the fixed main frame;

at least a first rack and pinion assembly, including a first rack and a first pinion, to move the external cylindrical roller in translation relative to the first auxiliary frame;

at least a second rack and pinion assembly, including a second rack and a second pinion, to move one of the conical rollers relative to the second auxiliary frame;

a first supply system for supplying a first variable volume chamber with fluid under a pressure greater than or equal to 100 bars, this first supply system including a first pipe, a first pump that delivers oil at an input pressure, a first tub, a first tared non-return valve that connects the first pipe to the tub and a second non-return valve, mounted in the opposite direction from the first non-return valve, at the outlet of the first pump, to prevent the pressurized fluid from circulating through the first pump from its outlet toward its inlet; and

a second supply system for supplying a second variable volume chamber with fluid under a pressure greater than or equal to 100 bars, this second supply system including a second pipe, a second pump that delivers oil at an input pressure, a second tub, a third tared non-return valve that connects the second pipe to the second tub and a fourth non-return valve, mounted in the opposite direction from the third non-return valve, at the outlet of the second pump, to prevent the pressurized fluid from circulating through the second pump from its outlet toward its inlet

at least one electric geared motor, different from the first and second driving motors, to drive at least one of the first and second pinions of the first and second pinion and rack assemblies, wherein:

the electric geared motor is fixedly mounted relative to one of the auxiliary frames;

a first fluid discharge mechanism is interposed in a first kinematic chain for transmitting force between the first rack and the external cylindrical roller moved by first rack, for absorbing a temporary overload transmitted to the kinematic chain, in case of an irregularity of a face of the annular part shaped by the roller;

the first fluid discharge mechanism comprises the first variable volume chamber supplied with pressurized fluid by the first supply system and the volume of which varies as a function of the relative position of the external cylindrical roller and of the first rack;

the first fluid discharge mechanism is configured to absorb the temporary overload, without the first rack being moved, by discharging at least part of the pressurized fluid from the first variable volume chamber;

the first kinematic chain is configured so that, in case of irregularity protruding on the surface of an annular part shaped by the external cylindrical roller, the movement caused by this irregularity on a first transmission bar of the kinematic chain tends to drive the pressurized fluid from the first variable volume chamber into the first tub via the first tared non-return valve, by reducing the volume of the first variable volume chamber,

a second fluid discharge mechanism is interposed in a second kinematic chain between the second rack of the second rack and pinion assembly and the conical roller and comprising the second variable volume chamber supplied with pressurized fluid by the second supply system and the volume of which varies as a function of the relative position of the conical roller and of the second rack, and

the second kinematic chain is configured so that, in case of irregularity protruding on the surface of an annular part shaped by the conical roller, the movement caused by this irregularity on a second transmission bar of the second kinematic chain tends to drive the pressurized fluid from the second variable volume chamber into the second tub via the second tared non-return valve, by reducing the volume of the second variable volume chamber.

2. The rolling mill according to claim **1**, wherein the first transmission bar is for transmitting a movement to the roller for moving the first rack along a longitudinal axis of the first transmission bar and wherein the first variable volume chamber is defined between

on the one hand, the first transmission bar or a part secured to the first transmission bar; and

on the other hand, the first rack or a part rigidly fastened to the first rack, or

wherein the second transmission bar is for transmitting a movement to the roller for moving the second rack along a longitudinal axis of the second transmission bar and wherein the second variable volume chamber is defined between

on the one hand, the second transmission bar or a part secured to the second transmission bar; and

on the other hand, the second rack or a part rigidly fastened to the second rack.

3. The rolling mill according to claim **2**, wherein the first variable volume chamber is defined inside the first transmission bar, or

wherein the second variable volume chamber is defined inside the second transmission bar.

4. The rolling mill according to claim **2**, wherein the first variable volume chamber is defined, along the longitudinal axis of the first transmission bar, between the first rack and the first transmission bar, or

wherein the second variable volume chamber is defined, along the longitudinal axis of the second transmission bar, between the second rack and the second transmission bar.

5. The rolling mill according to claim **2**, wherein part of the first transmission bar is received sealably in an internal cavity defined by the first rack and in that the first variable volume chamber is formed by the portion of this cavity not occupied by the first transmission bar, or

wherein part of the second transmission bar is received sealably in an internal cavity defined by the second rack and in that the second variable volume chamber is formed by the portion of this cavity not occupied by the second transmission bar.

6. The rolling mill according to claim **5**, wherein it comprises a system for supplying the first variable volume chamber with fluid under a pressure greater than or equal to 100 bars, and wherein the first variable volume chamber is connected to the first fluid supply system by a pipe that passes through the first rack, or

wherein it comprises a system for supplying the second variable volume chamber with fluid under a pressure greater than or equal to 100 bars, and wherein the second variable volume chamber is connected to the second fluid supply system by a pipe that passes through the second rack.

7. The rolling mill according to claim **1**, wherein the first fluid discharge mechanism comprises a piston secured to the first rack and a face of which defines the first variable volume chamber, or

wherein the second fluid discharge mechanism comprises a piston secured to the second rack and a face of which defines the second variable volume chamber.

8. The rolling mill according to claim **7**, wherein the first transmission bar is configured to transmit a movement to the roller for moving the first rack along a longitudinal axis of the first transmission bar, wherein the first variable volume chamber is defined between on the one hand, the first transmission bar or a part secured to the first transmission bar; and on the other hand, the first rack or a part rigidly fastened to the first rack and wherein the piston is mounted sliding inside the first transmission bar, along the longitudinal axis of the first transmission bar, or

wherein the second transmission bar is configured to transmit a movement to the roller for moving the second rack along a longitudinal axis of the second transmission bar, wherein the second variable volume chamber is defined between on the one hand, the second transmission bar or a part secured to the second transmission bar; and on the other hand, the second rack or a part rigidly fastened to the second rack and wherein the piston is mounted sliding inside the second transmission bar, along the longitudinal axis of the second transmission bar.

9. The rolling mill according to claim **8**, wherein the piston is secured to the first rack via a rack support and a connecting rod between the rack support and the piston, the rack support and the connecting rod also being mounted sliding inside the first transmission bar, along the longitudinal axis of the first transmission bar, or

wherein the piston is secured to the second rack via a rack support and a connecting rod between the rack support and the piston, the rack support and the connecting rod also being mounted sliding inside the second transmission bar, along the longitudinal axis of the second transmission bar.

10. The rolling mill according to claim **9**, wherein it comprises members for guiding in translation, along the longitudinal axis of the first transmission bar and inside the first transmission bar, the rack support or the connecting bar or both the rack support and the connecting bar, or

wherein it comprises members for guiding in translation, along the longitudinal axis of the second transmission bar and inside the second transmission bar, the rack support or the connecting bar or both the rack support and the connecting bar.

11. The rolling mill according to claim **8**, wherein the first variable volume chamber is defined between the face of the piston and a cover that closes off an internal volume of the first transmission bar, opposite the roller, or

wherein the second variable volume chamber is defined between the face of the piston and a cover that closes off an internal volume of the second transmission bar, opposite the roller.

12. The rolling mill according to claim **10**, wherein the members for guiding include guiding skids.

13. The rolling mill according to claim **1**, wherein each roller translatable relative to one of the first and second auxiliary frames is moved by a pinion and rack assembly driven by an electric geared motor mounted fixedly relative to said one of the first and second auxiliary frames, with insertion of a fluid discharge mechanism in the kinematic force transmission chain between each rack and the roller driven by said rack.

14. The rolling mill according to claim **1**, wherein the system for supplying at least one of the first variable volume chamber and the second variable volume chamber with fluid under pressure supplies fluid under a pressure greater than or equal to 200 bars.

15. The rolling mill according to claim **1**, wherein the system for supplying at least one of the first variable volume chamber and the second variable volume chamber with fluid under pressure supplies fluid under a pressure of 250 bars.

16. The rolling mill according to claim **1**, wherein at least one of the first fluid discharge mechanism and the second fluid discharge mechanism is configured to protect an electric motor and a reduction gear of the electric geared motor and protect the rack assembly against violent accelerations resulting from surface irregularities on the annular part during shaping in the rolling mill.

17. The rolling mill according to claim **1**, wherein it includes

a first electric geared motor, different from the first and second driving motors, to drive the pinion of the first pinion and rack assembly, said first electric geared motor being fixedly mounted relative to the first auxiliary frame;

a second electric geared motor, different from the first and second driving motors, to drive the pinion of the second pinion and rack assembly, said second electric geared motor being fixedly mounted relative to the second auxiliary frame.

18. A method for controlling the position of at least one roller for shaping a face of an annular part to be shaped within a circular rolling mill that comprises:

a fixed main frame;

an internal cylindrical roller intended to shape an internal radial face of the annular part and an external cylindrical roller intended to shape an external radial face of the annular part and rotated by a first driving electric motor, the internal cylindrical roller and the external cylindrical roller being supported by a first auxiliary frame mounted on the fixed main frame;

an upper conical roller intended to shape a front face of the annular part and a lower conical roller intended to shape an opposite front face of the annular part, the upper conical roller and the lower conical roller being each rotated by a second driving electric motor and supported by a second auxiliary frame mounted on, and movable with respect to, the fixed main frame;

at least a first rack and pinion assembly, including a first rack and a first pinion, to move the external cylindrical roller or one of the conical rollers relative to the fixed main frame;

at least a second rack and pinion assembly, including a second rack and a second pinion, to move one of the conical rollers relative to the second auxiliary frame;

a first supply system for supplying a first variable volume chamber, integrated into a first discharge mechanism interposed in a first kinematic force transmission chain between the first rack and the external cylindrical roller moved by the first rack, with fluid under a pressure greater than or equal to 100 bars, the first supply system including a first pipe, a first pump that delivers oil at an input pressure, a first tub, a first tared non-return valve that connects the first pipe to the first tub and a second non-return valve, mounted in the opposite direction from the first non-return valve, at the outlet of the first pump, to prevent the pressurized fluid from circulating through the first pump from its outlet toward its inlet;

a second supply system for supplying a second variable volume chamber, integrated into a second discharge mechanism disposed in a second kinematic force transmission chain between the second rack and the conical collar, with fluid under a pressure greater than or equal to 100 bars, the second supply system including a second pipe, a second pump that delivers oil at an input pressure, a second tub, a third tared non-return valve that connects the second pipe to the second tub and a fourth non-return valve, mounted in the opposite direction from the third non-return valve, at the outlet of the second pump, to prevent the pressurized fluid from circulating through the second pump from its outlet toward its inlet; and

at least one electric geared motor, different from the first and second driving motors, to drive at least one of the first and second pinions of the first and second pinion and rack assemblies,

wherein this method comprises the following steps:

a) supplying pressurized fluid to the first variable volume chamber, to stiffen the first kinematic chain during normal operation of the rolling mill in order to absorb a temporary overload transmitted to the first kinematic chain in case of irregularity of the surface shaped by the roller, and

b) absorbing the temporary overload, without moving the first rack, by discharging at least part of the pressurized fluid from the first variable volume chamber into the first tub via the first tared non-return valve, by reducing the volume of the first variable volume chamber, in case of irregularity on the face of the annular part that is shaped by the roller.

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